Case Study

The use of a geophysical tool (resistivity) to aid in the development of the Remedial Action Groundwater Monitoring Program

Simplot OU of the Eastern Michaud Flats Superfund Site, Pocatello, Idaho

Bernie Zavala
U.S. Environmental Protection Agency, Region 10

Spring TSP meeting
Groundwater Forum Business Session
Oklahoma City, Oklahoma
May 2, 2012

Acknowledgements

Dale Werkema, Ph.D, USEPA, ORD/Las Vegas

Kira Lynch, EPA-Region 10

Chris Bellovary, EPA-Region 10

Buz Cotton, Formation Environmental

Monty Johnson, J.R. Simplot Co.

Overview of this Presentation

- Rationale for the resistivity survey
- Brief overview of the technology
- Brief overview of the CSM
- Results of the survey
- Ground truth prior to the installation of the monitoring wells
- Observations and take home message
- Questions

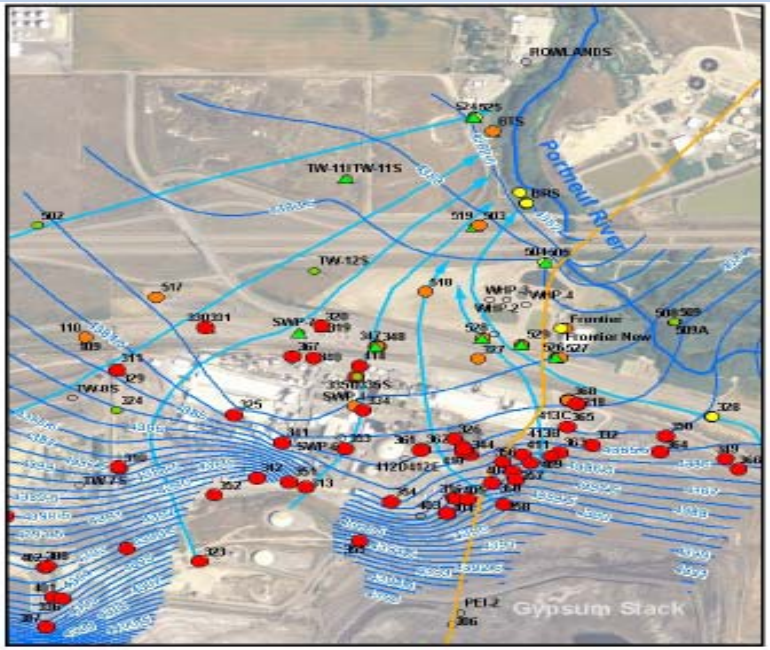
Rationale / objectives for the resistivity survey

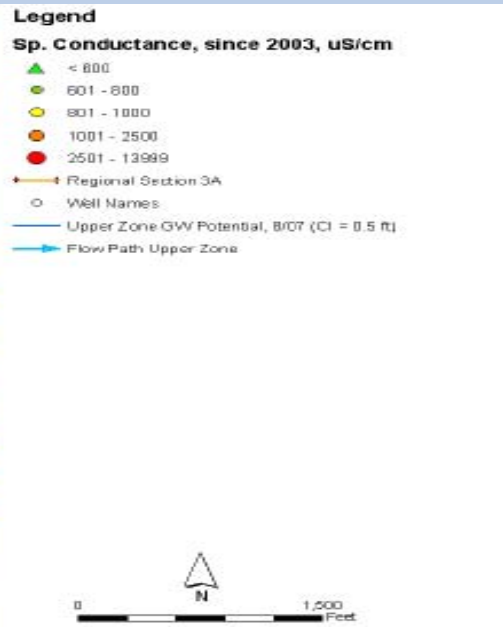
- Aid in refining the delineation of the lateral and vertical extent of contaminated groundwater.
- Provide information to help locate performance assessment monitoring wells for the site remedy (groundwater extraction).
- Assist in the locations of the compliance points prior to the discharge into surface water.

Why a resistivity survey?

- The hydrogeology changes abruptly once groundwater flows passes the facility, from a low to moderate hydraulic conductivity (10 ft/day) to a high conductivity (750 ft/day).
- The COCs can easily be detected by a resistivity survey due to its specific conductance. The plume primary consists of sulfate, orthophosphate and arsenic.

Field measurements of specific conductance in groundwater





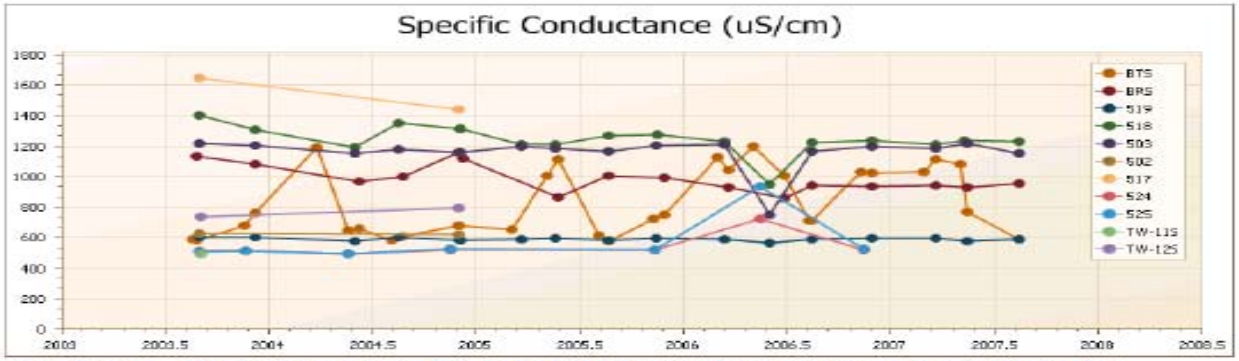


Figure 2-6: Field measurements of specific conductance in groundwater samples collected from wells in the investigation area.

Taken from the *Work Plan Groundwater Geophysical Investigation*, NewFields, 4/2008

Brief overview of the technology

EM Induction (conductivity) Well Logging – EM-39

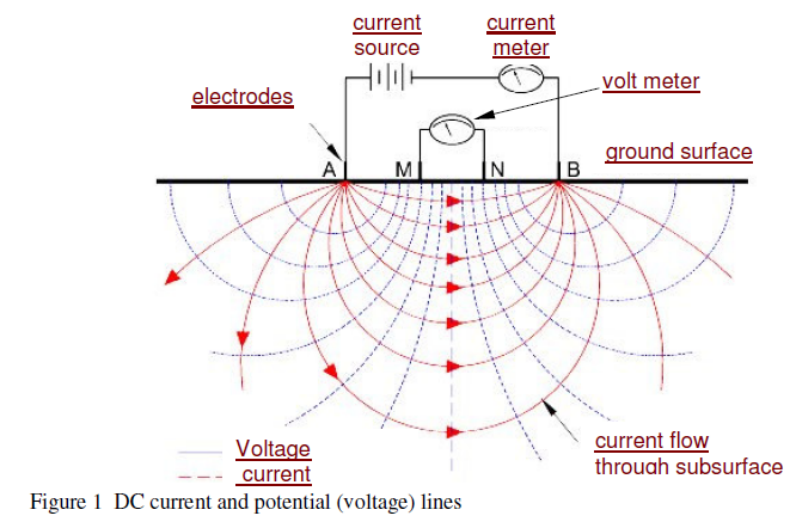
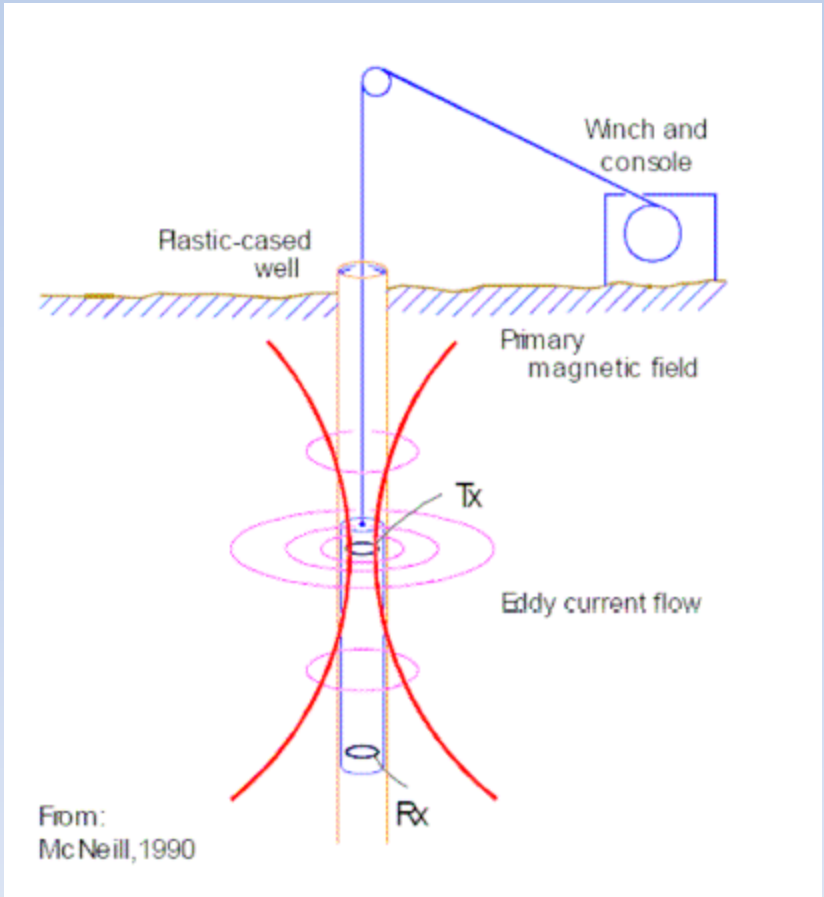
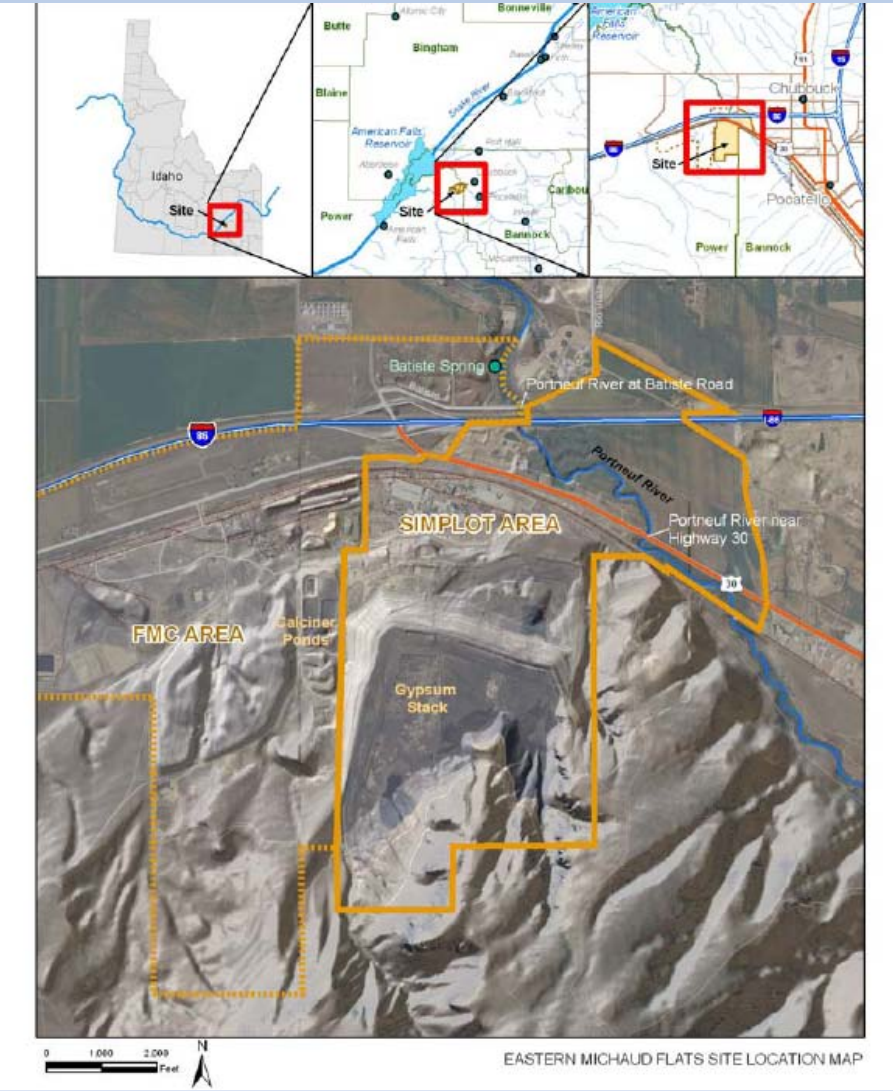


Figure 1 DC current and potential (voltage) lines

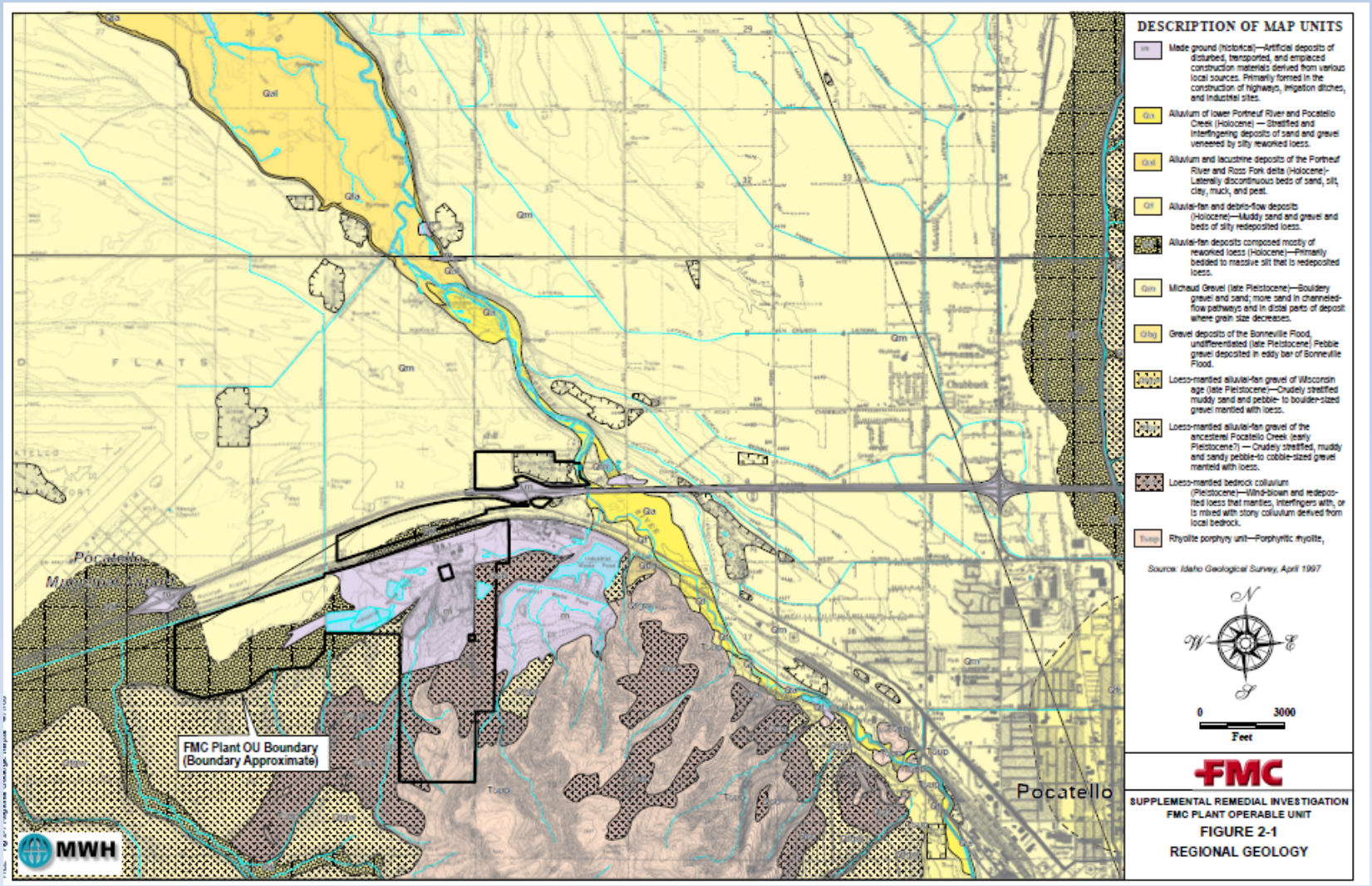
Direct current
Electrical
Resistivity
Profiling



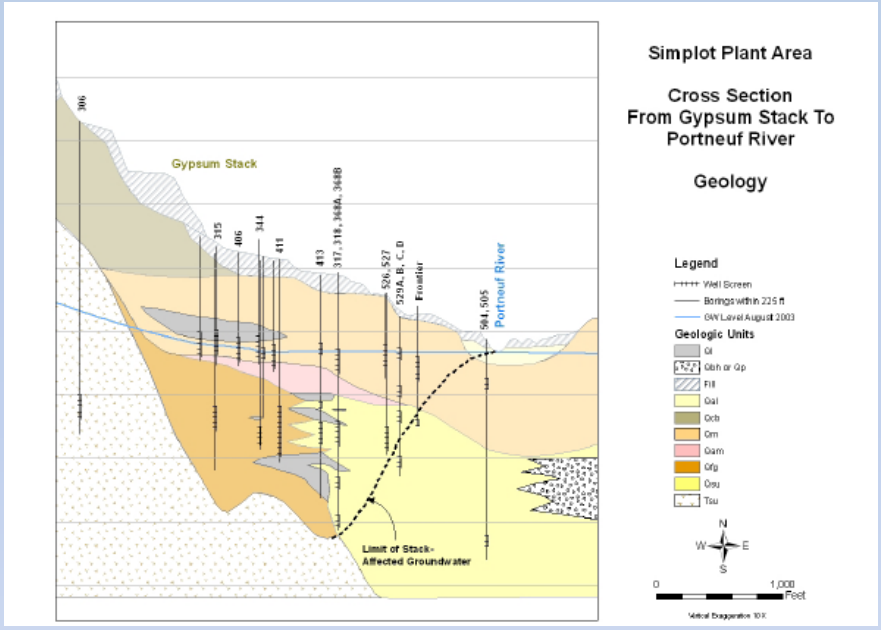
EMF Superfund site – Simplot OU Location Map

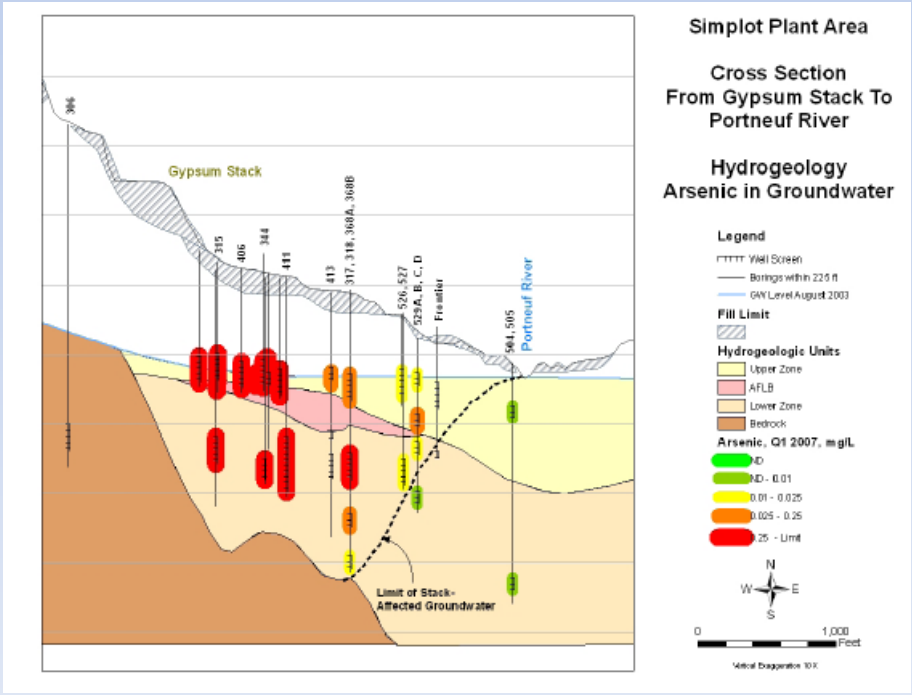


Brief overview of the CSM

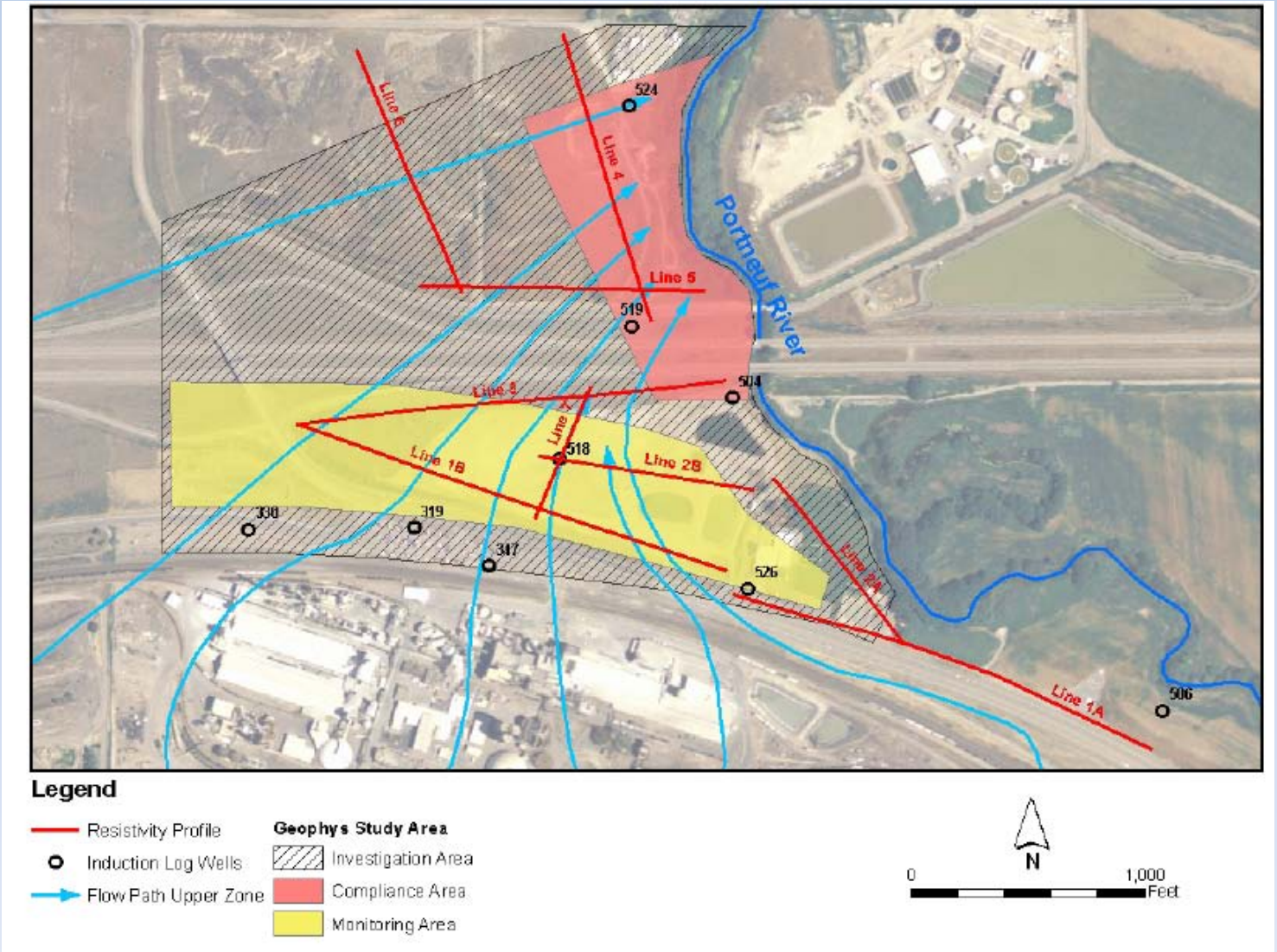


CSM – Hydrogeological Cross-section

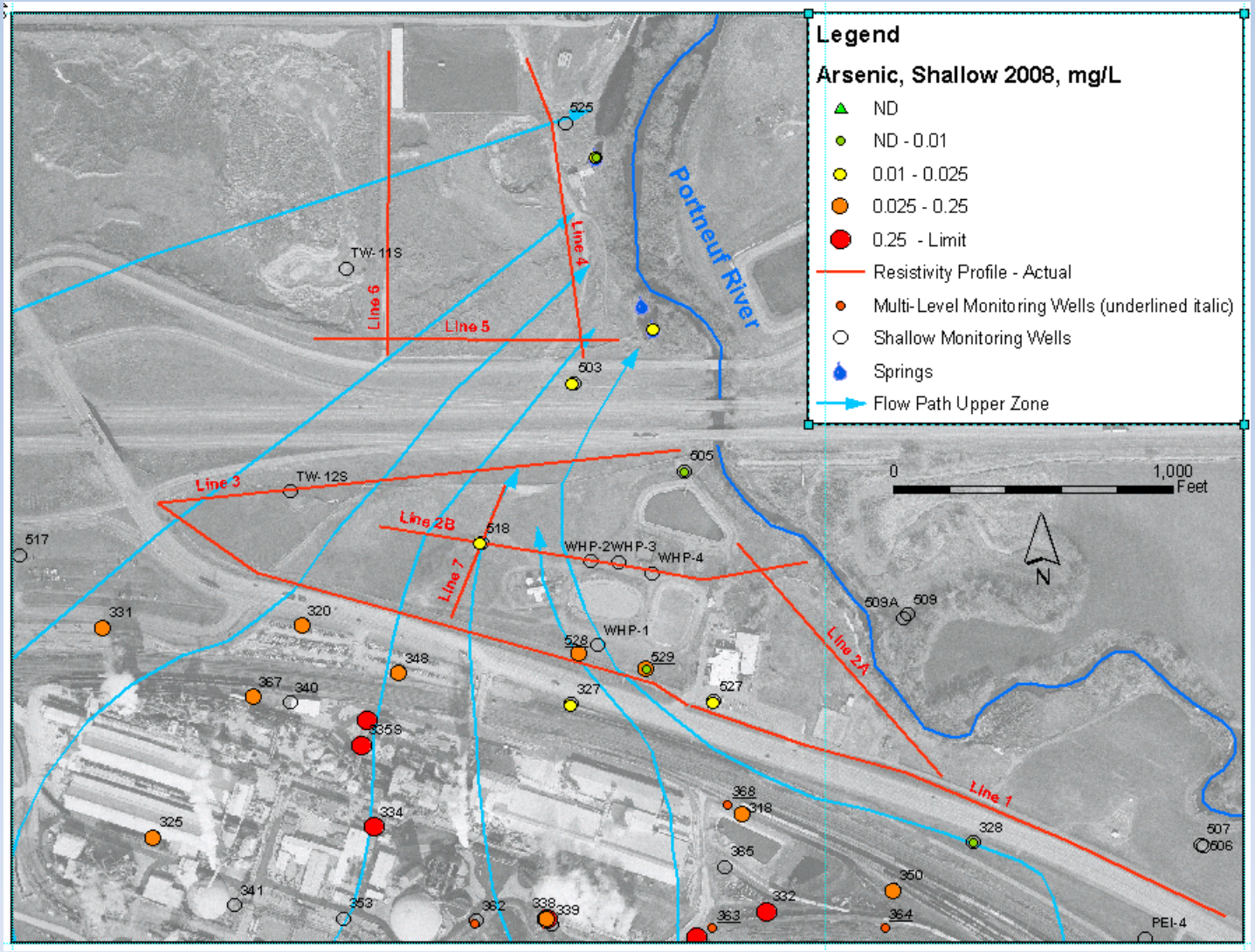


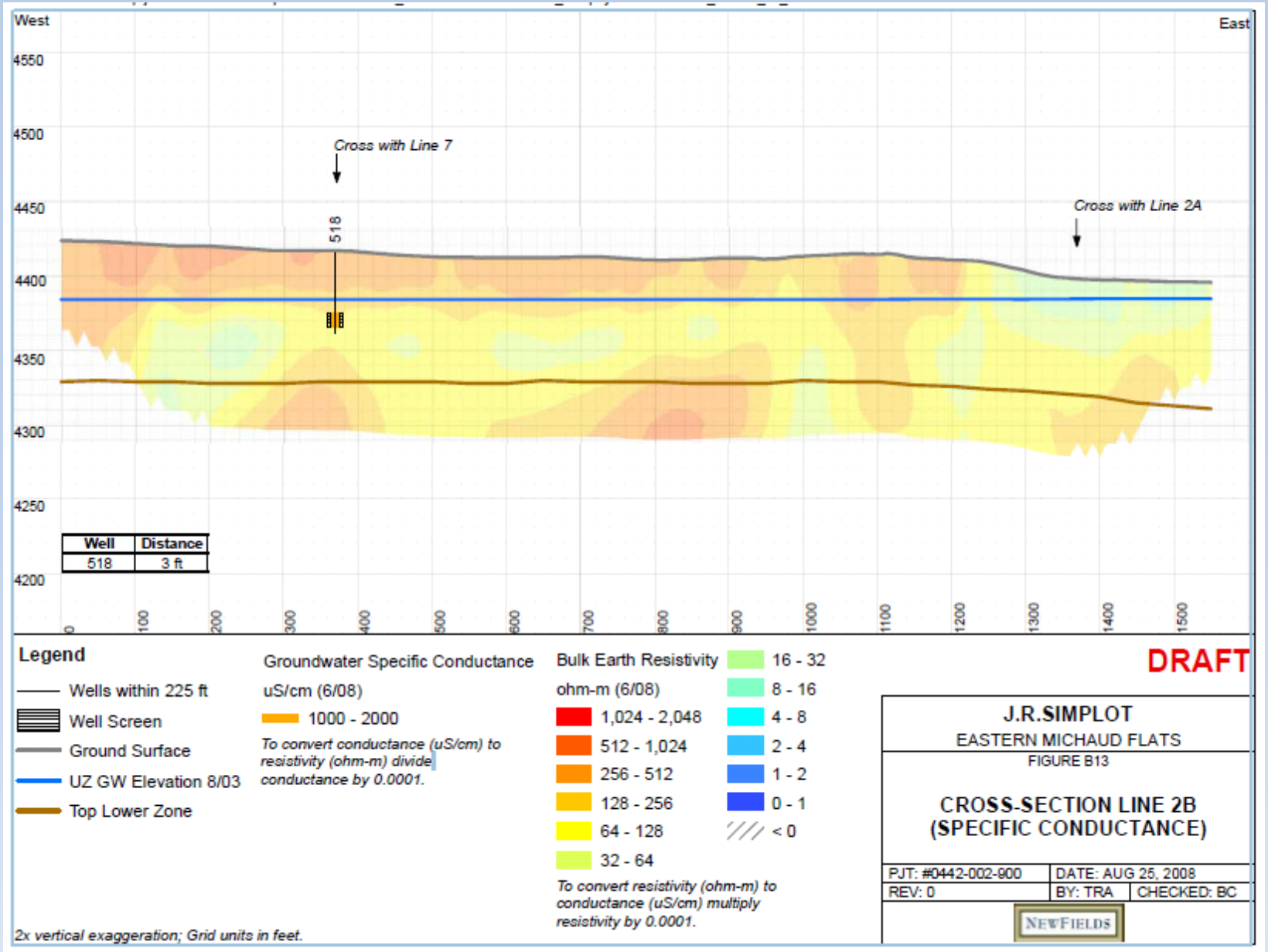


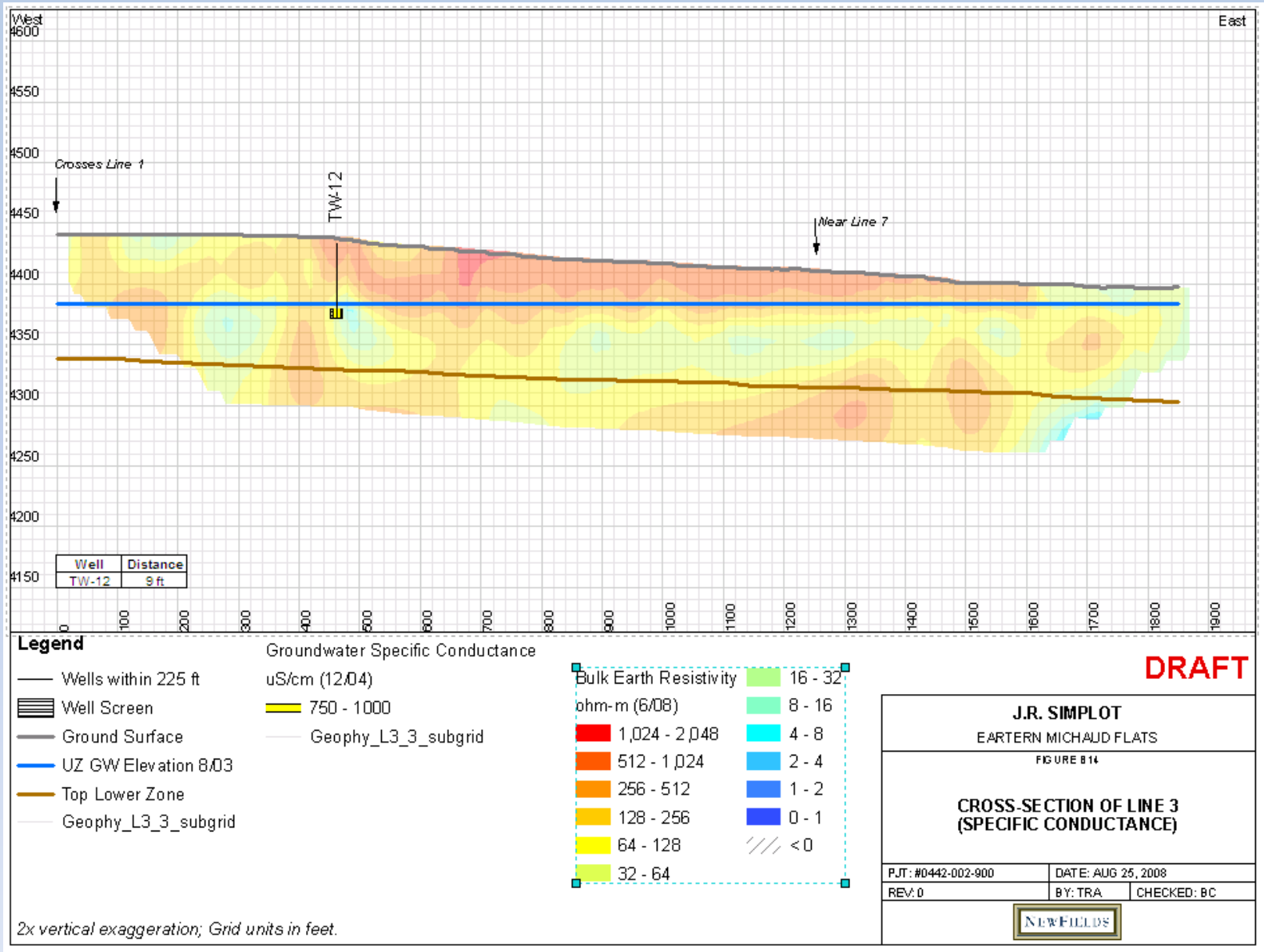
Location of resistivity lines and location of wells in which down hole logging will be performed

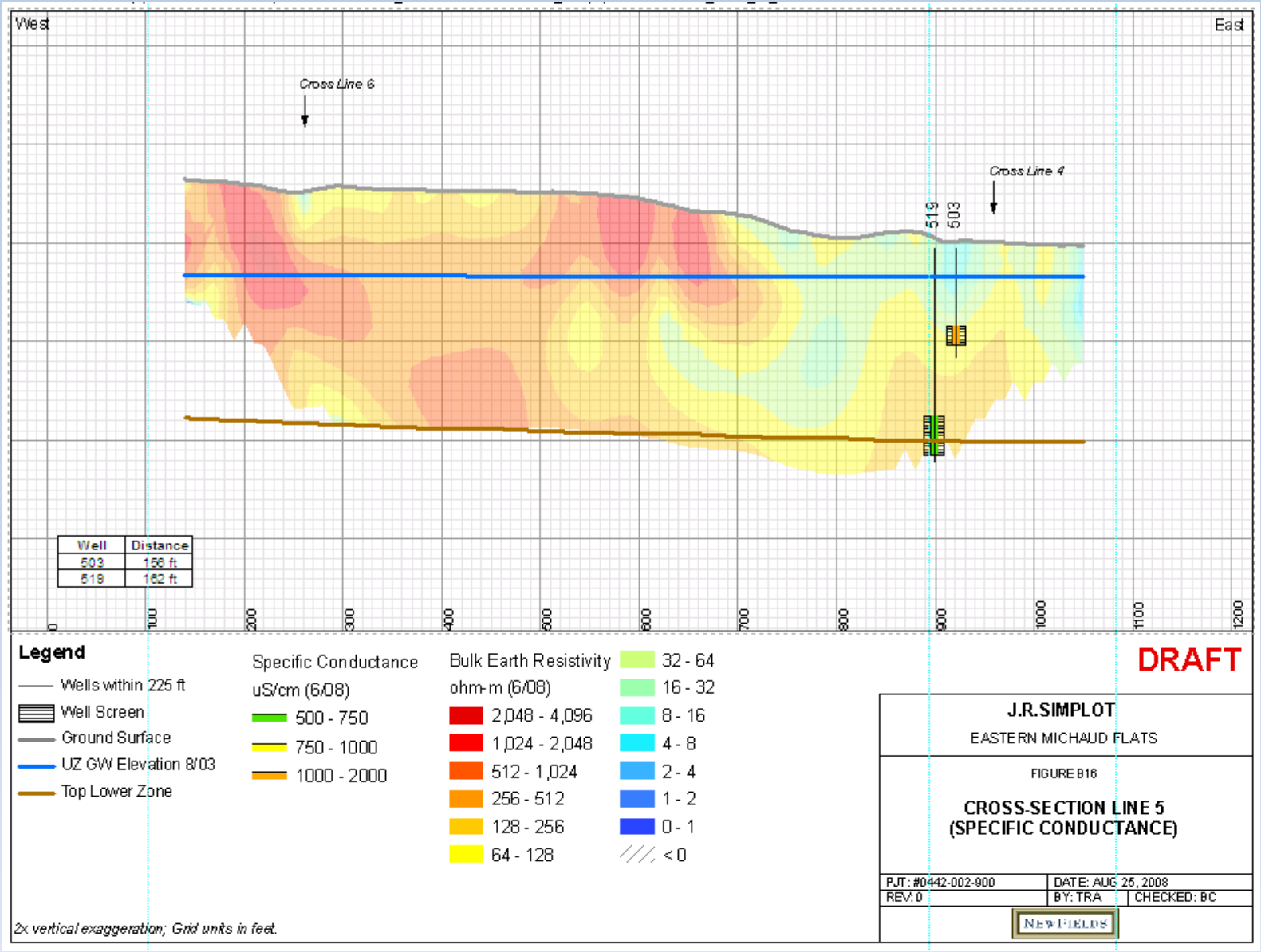


Results of the survey

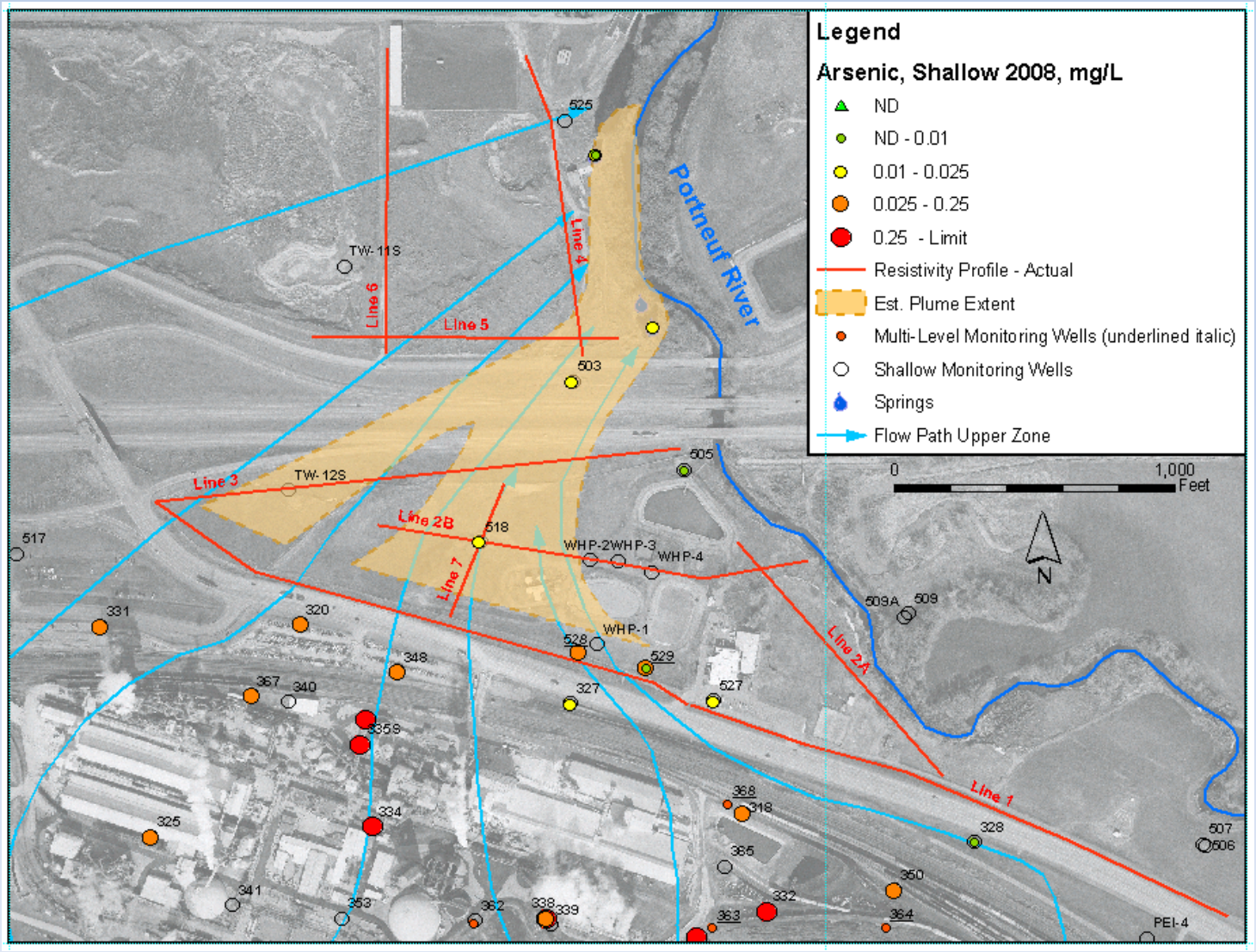



West
East
4550
4500
4450
4400
4350
4300
4250
4200
Cross with Line 7
Cross with Line 2A
518
Well
Distance
518
3 ft
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
Legend
Wells within 225 ft
Well Screen
Ground Surface
UZ GW Elevation 8/03
Top Lower Zone
Groundwater Specific Conductance
uS/cm (6/08)
1000 - 2000
To convert conductance (uS/cm) to resistivity (ohm-m) divide conductance by 0.0001.
Bulk Earth Resistivity
ohm-m (6/08)
1,024 - 2,048
512 - 1,024
256 - 512
128 - 256
64 - 128
32 - 64
16 - 32
8 - 16
4 - 8
2 - 4
1 - 2
0 - 1
< 0
To convert resistivity (ohm-m) to conductance (uS/cm) multiply resistivity by 0.0001.
2x vertical exaggeration; Grid units in feet.
DRAFT
J.R.SIMPLOT
EASTERN MICHAUD FLATS
FIGURE B13
CROSS-SECTION LINE 2B
(SPECIFIC CONDUCTANCE)
PJT: #0442-002-900
DATE: AUG 25, 2008
REV: 0
BY: TRA
CHECKED: BC
NEWFIELDS

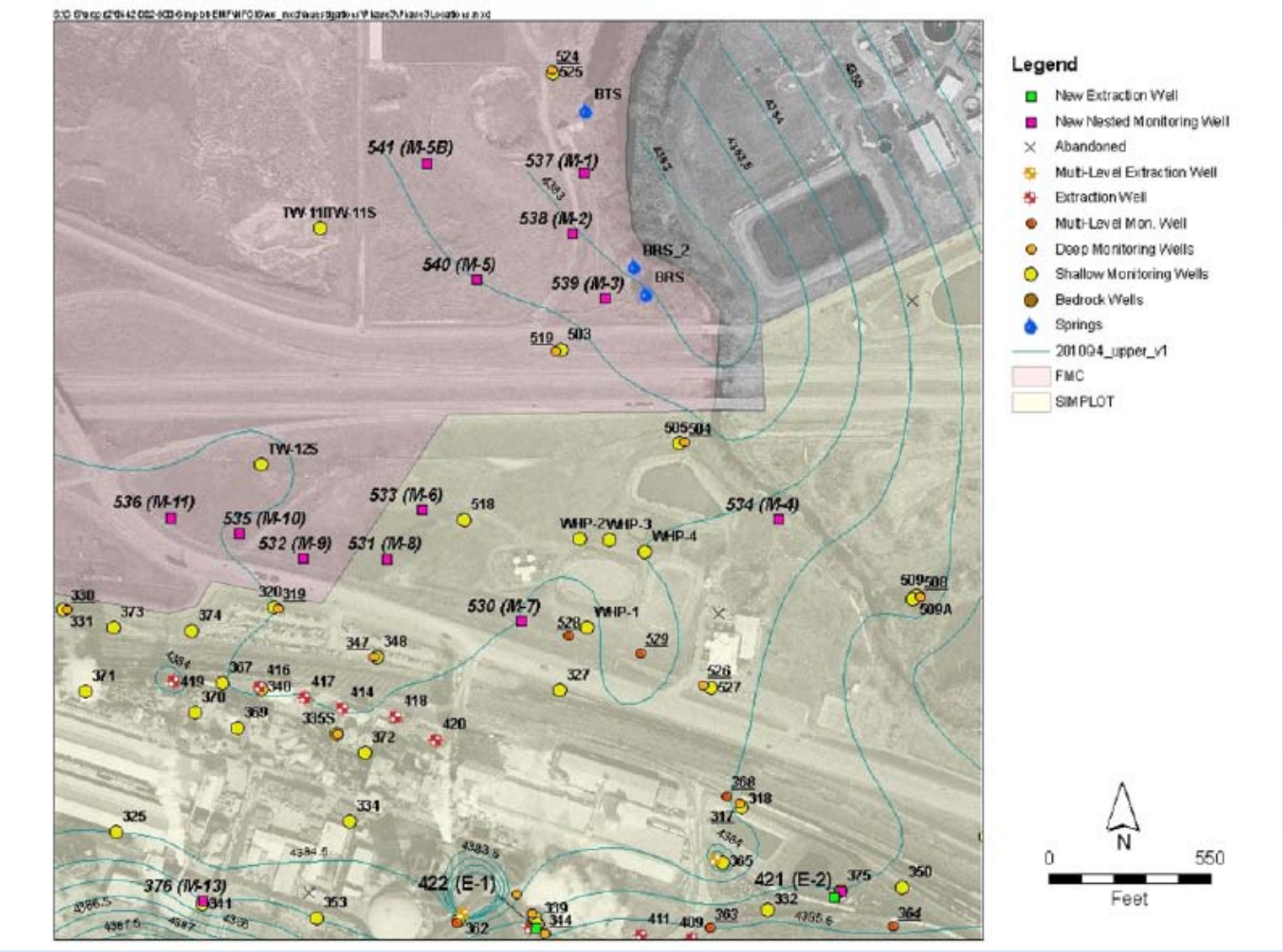

West
East
4600
4550
4500
4450
4400
4350
4300
4250
4200
4150
Crosses Line 1
TW-12
Near Line 7
Well
Distance
TW-12
9 ft
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
Legend
Wells within 225 ft
Well Screen
Ground Surface
UZ GW Elevation 8/03
Top Lower Zone
Geophy_L3_3_subgrid
Groundwater Specific Conductance
uS/cm (12/04)
750 - 1000
Geophy_L3_3_subgrid
Bulk Earth Resistivity
ohm-m (6/08)
1,024 - 2,048
512 - 1,024
256 - 512
128 - 256
64 - 128
32 - 64
16 - 32
8 - 16
4 - 8
2 - 4
1 - 2
0 - 1
< 0
2x vertical exaggeration; Grid units in feet.
DRAFT
J.R. SIMPLOT
EARTERN MICHAUD FLATS
FIGURE B14
CROSS-SECTION OF LINE 3
(SPECIFIC CONDUCTANCE)
PJT: #0442-002-900
DATE: AUG 25, 2008
REV: 0
BY: TRA
CHECKED: BC
NEWFIELDS


West
East
Cross Line 6
Cross Line 4
519
503
Well
Distance
503
156 ft
519
162 ft
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Legend
Wells within 225 ft
Well Screen
Ground Surface
UZ GW Elevation 8/03
Top Lower Zone
Specific Conductance
uS/cm (6/08)
500 - 750
750 - 1000
1000 - 2000
Bulk Earth Resistivity
ohm-m (6/08)
2,048 - 4,096
1,024 - 2,048
512 - 1,024
256 - 512
128 - 256
64 - 128
32 - 64
16 - 32
8 - 16
4 - 8
2 - 4
1 - 2
0 - 1
< 0
DRAFT
J.R.SIMPLOT
EASTERN MICHAUD FLATS
FIGURE B16
CROSS-SECTION LINE 5
(SPECIFIC CONDUCTANCE)
PJT: #0442-002-900
DATE: AUG 25, 2008
REV: 0
BY: TRA
CHECKED: BC
NEWFIELDS
2x vertical exaggeration; Grid units in feet.

(Guess)estimate of the plumes



Pilot borings and vertical profiling



Ground truth process

- Installed pilot borings with a Sonic drill rig.
- Collected water samples every 10 feet (typically 6-depths).
- Used onsite analysis, Hach Field test kits for sulfate and phosphorus .
- This information was used for selecting the screen intervals and number of wells per location.

Example of groundwater quality profiling data for the assessment area

Table 2-5: Summary of data collected during groundwater profile sampling

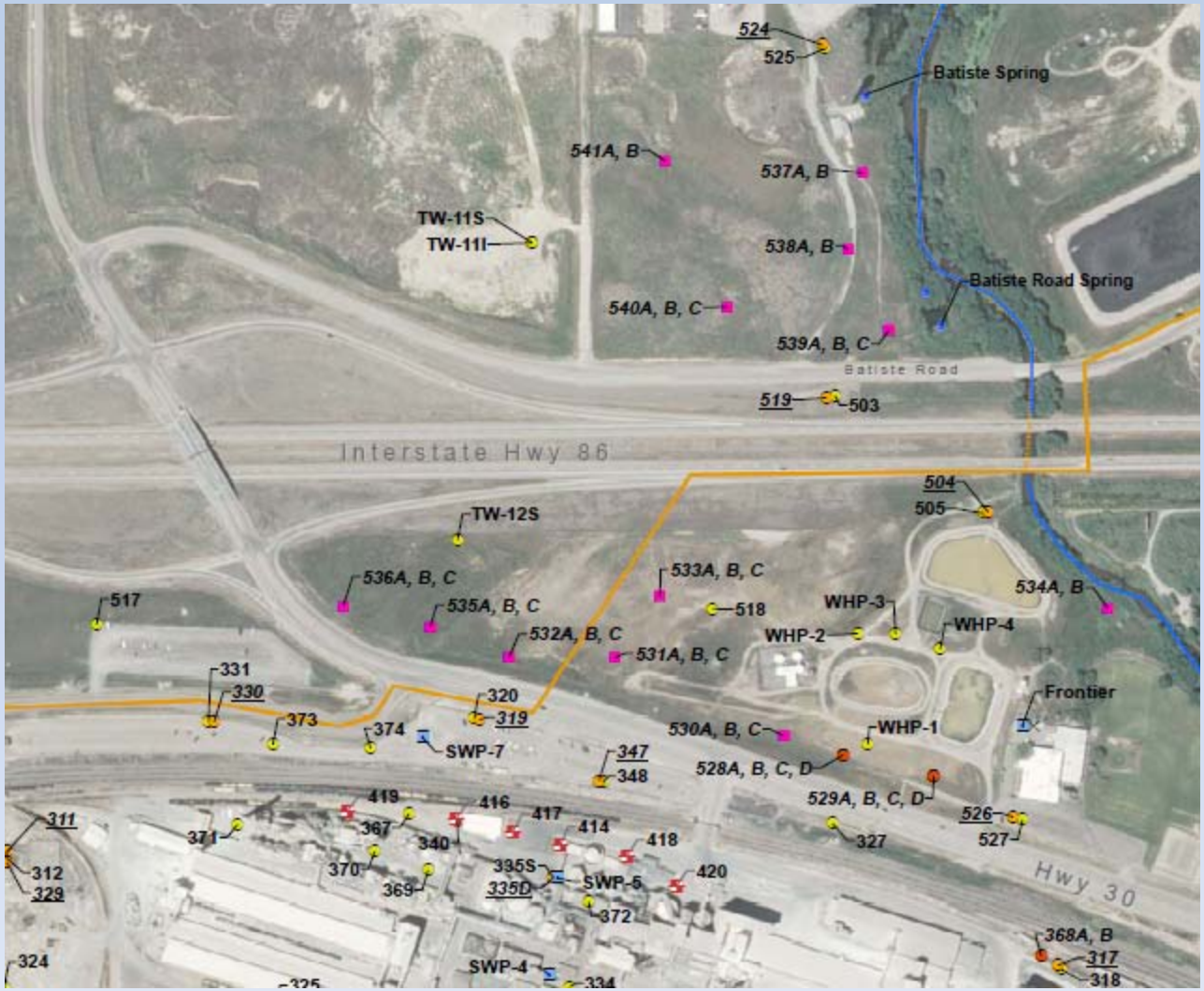
Boring	Sample Depth (ft bgs)	Date	Pumping Rate (gpm)	Casing Volume (gal)	Total Purged (gal)	Temp (C)	pH	Specific Cond. (uS/cm)	Turbidity (NTU)	Sulfate (mg/L)	Phosphorus (mg/L)	Comment
376	107	10/8	10	26.1	705	16.66	7.37	622	56.97	80	0	
530	47	9/11	24	40.0	884	13.94	6.8	1184	10.40	200	25	
530	57	9/11	30	66.0	810	14.01	6.87	1259	519	300	30	
530	67	9/13	24	67.2	792	14.13	6.48	2060	4.09	750	105	
530	77	9/13	20	119.6	500	15.85	6.63	1853	181.2	350	70	
530	87	9/13	20	130.0	440	15.61	7.57	624	33.59	50	2	
530	97	9/13	20	175.5	440	16.12	7.64	612	39.59	60	1	
531	47	9/14	18	27.3	270	17.32	6.4	1900	64.13	350	35	
531	57	9/14	24	54.3	480	17.08	6.37	1880	304.2	250	29	
531	67	9/14	21	81,0	735	16.74	6.38	2074	99.92	700	25	
531	77	9/14	21	106.9	735	15.9	6.54	1599	55.92	430	28	
531	87	9/14	24	162.2	624	15.39	7.66	535	10.56	61	0.2	
531	97	9/14	21	159.9	525	14.8	7.7	514	10.62	57	0.2	
532	57	9/15	14	50.7	370	16.89	6.48	2573	27.12	400	24	
532	67	9/15	--	88.4	40	22.46	7.47	638	-			casing blocked off in boulder, no sample
532	77	9/15	20	158.6	800	17.86	5.93	2840	275.4	450	130	
532	87	9/16	18	146.2	810	14.85	7.59	550	5.07	59	0.3	
532	97	9/16	14	143.9	350	14.64	7.63	553	86.11	58	1.0	
533	37	9/16	5	16.2	125	18.48	6.47	1753	21.45	100	30	
533	47	9/16	18	43.3	360	15.65	6.58	1350	24.28	250	20	
533	57	9/17	18	70.9	450	15.53	6.52	1520	436.4	200	30	

Example of groundwater quality profiling data for the compliance area

Table 2-5: Summary of data collected during groundwater profile sampling

Boring	Sample Depth (ft bgs)	Date	Pumping Rate (gpm)	Casing Volume (gal)	Total Purged (gal)	Temp (C)	pH	Specific Cond. (uS/cm)	Turbidity (NTU)	Sulfate (mg/L)	Phosphorus (mg/L)	Comment
537	27	9/22	20	47.9	400	14.65	6.87	987	451.4	80	20	
537	37	9/22	20	99.7	500	14.65	6.9	889	110.5	110	7.5	
537	47	9/22	18	114.9	630	14.94	7.06	697	24.66	70	0.9	
537	57	9/22	20	127.0	800	14.69	7.13	779	124.6	70	0.5	
537	67	9/22	20	158.2	700	14.52	7.7	549	381.3	35	0.4	
537	77	9/22	20	168.9	500	14.46	7.72	548	26.0	43	0.4	
538	27	9/23	14	39.2	350	14.35	7.09	8432	71.83	170	18	
538	37	9/23	14	68.1	350	14.46	6.93	879	69.06	250	18	
538	47	9/23	13.2	90.2	540	14.46	7.07	812	158.9	220	18	
538	57	9/23	20	116.4	400	14.55	7.11	747	--	120	19	No turbidity taken, filtered sample.
538	67	9/23	20	141.5	400	14.69	7.42	511	1100	45	1.4	
538	77	9/23	20	168.4	500	14.56	7.85	473	446.8	48	0.8	
539	27	9/24	20	41.8	315	14.77	7.3	786	44.98	60	4.3	
539	37	9/24	20	65.8	400	13.97	7.4	796	277.5	75	0.7	
539	47	9/24	20	91.9	400	14.14	7.32	800	856.1	75	1.6	
539	57	9/24	20	118.8	600	14.12	7.28	828	392.0	120	1.1	
539	67	9/24	28	143.6	700	13.96	7.12	882	230.8	175	0.8	
539	77	9/24	20	169.7	600	14.26	7.42	614	248.2	65	1.6	
539	87	9/24	20	196.2	500	14.49	7.83	453	153.7	10	0.1	
540	47	10/5	15	35.2	525	14.89	6.94	769	32.16	95	28.5	
540	57	10/5	20	62.1	800	13.95	6.92	854	138.1	190	6.5	

Current Monitoring Network in the Assessment and Compliance Areas



November 2010 Groundwater data from selected Monitoring Wells from the Assessment and Compliance Areas (mg/l)

Compliance Area

Well ID	As	T.Phos
538 A	0.031	12.7
B	0.003	0.70
537A	0.027	8.1
B	0.003	0.02

Assessment Area

Well ID	As	T.Phos.
532A	0.050	1.98
B	0.117	539
533A	0.025	8.4
B	0.075	32.2

Observations and take home message

- The resistivity survey helped in meeting our three objectives .
- The sonic rig allowed us to conduct a successful vertical profiling using the field kits.
- Always good to use multi lines of evidences.

Questions